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Specifications

1. Title of Invention: Automatic cut-out system

2. Claims:

An automatic cut-out system, characterized in that it comprises an original reading means which reads a color original, an image memory which stores the color image data read by this original reading means, a color sense information calculating means which reads said color image data from said image memory and calculates the color sense information in the RGB space, a brightness information calculating means which calculates the differences in brightness based on said color sense information, a correction calculating means which performs a

weighted correction calculation on said brightness differences based on said color sense information, a color image edge detecting means which detects the edge information of the color image data stored in said image memory, an edge displaying means which displays said edge information on a display device, a correction indicating device which indicates the correction positions and correction areas of said edge information displayed on said display device, a mask data making means which makes mask data while correcting the correction positions and correction areas displayed on said correction indicating device, a vector converting means which converts said mask data to vector data, a vector data correcting means which thins out and corrects the number of changing points of said vector data, a noise removing means which automatically removes only the noise data in said vector data corrected by said vector data correcting mean, and a film output means which reads the color image data stored in said image memory, based on the vector data with the noise removed by said noise removing means, and clips and outputs it to printing film plates.

3. Detailed Explanation of Invention:

## Field of Use in Industry

This invention concerns a device which extracts the background part from an inputted image and makes a printing plate film; in particular, it concerns a device which detects the edge points from a color image and makes a printing plate film from which the distinct background part has been cut out.

## Prior Art

Many solid screen parts are present in color printed objects; the process of making places of these solid screen parts is performed by a special process which is different from the plate-making process for general color parts, the so-called tone materials.

As a device of this kind, a film original plate making device for solid screens, shown in Japan Published Unexamined Application No. 62-130059, has been proposed.

Fig. 6 is a block diagram which explains an example of the conventional film original plate making device for solid screens. 51 is a scanner; a line image is read and binary image data are inputted into a computer 53 through an interface 52. 54 is an external storage device; it stores the line image data inputted from the scanner 41. 55 is an interface; it outputs the image data processed by the computer 53 to an output scanner 56. The output scanner 56 outputs a film original plate for each printing plate color, based on the image data processed by the computer 53. 57 is a floppy disk device; it stores the line image data which has been imported primarily from the scanner 51. 60 is a color separation device; is comprises a computer 61, a display 62 connected to the computer 61, a tablet 63

which inputs position data, a floppy disk device 64, etc.

Next, the processing of the line image data imported from the scanner 51 will be explained.

The line image which is inputted is converted to a binary image by the scanner 51; once imported into the internal memory of the computer 53, image processing is performed, including reading out each specific line and removing the garbage data contained in the binary image data, and the results are stored in the external storage device 54.

Next, the image data stored in the external memory device 54 is outputted to the color separation device 60 on the instruction of the computer 53, and the specific color separation processing (the parts in the image frames which are drawn in the line images and the external color painting processing) is executed corresponding to the color instructions.

The color separation data, which has been separated with respect to the line image, is transferred to the computer 53. In this way, the computer 53 outputs the film original plate data for solid screens to the output scanner 56, for each plate color, while making reference to the color separation data.

Problems Which This Invention Seeks to Solve

However, there are cases in which only the necessary parts are cut out of an original photograph and used. For example, in some cases, a rectangular original photograph is trimmed to a heart shape before it is used, or only an object in the original photograph is cut out and used in combination with another original photograph. In these cases, a cutting-out process is generally executed.

That is, a "clipping" is indicated on layout paper, following the outline of the needed pattern, by means of a tracing machine, tracing paper is placed on the original photograph, and the outline of the needed part is drawn. The unnecessary parts are crossed out with hash lines, indicating a clipping, and a cutting mask, etc., is made according to these clipping instructions, after which the images are combined.

However, what becomes the printed material is not only such images which are composed of a single color area; in some cases, colors gradually change, or there are negative and positive films for color photographs, etc., in which only specific objects in such color originals, e.g., persons or pieces of furniture, are extracted and film plates are made. In such cases, areas with different brightnesses, saturations, and hues are superimposed on the cut-out regions. Therefore, faithful film plates cannot be automatically made by the method described above. In the case of a color film original, the process is relegated to a hand operation, in which the film image is projected, a person makes a mask corresponding to the cut-out area, and this mask is superimposed on the film original, in order to make the desired film plates (Y, M, C, BK plates) of the color original. Therefore,

a number of problems are caused: the efficiency of the making of the film plates is markedly reduced, due to the complexity of the images of the film originals, the time required for the printing process is greatly lengthened, etc.

This invention was made in order to solve these problems. Its purpose is to obtain an automatic cut-out system which can make printing plates by extracting the outlines of specific objects from color originals; this is done by calculating the interrelationships between the brightness data, saturation data, and hue data in the color original.

## Means for Solving These Problems

The automatic cut-out system of this invention comprises an original reading means which reads a color original, an image memory which stores the color image data read by this original reading means, a color sense information calculating means which reads said color image data from said image memory and calculates the color sense information in the RGB space, a brightness information calculating means which calculates the differences in brightness based on said color sense information, a correction calculating means which performs a weighted correction calculation on said brightness differences based on said color sense information, a color image edge detecting means which detects the edge information of the color image data stored in said image memory, an edge displaying means which displays said edge information on a display device, a correction indicating device which indicates the correction positions and correction areas of said edge information displayed on said display device, a mask data making means which makes mask data while correcting the correction positions and correction areas displayed on said correction indicating device, a vector converting means which converts said mask data to vector data, a vector data correcting means which thins out and corrects the number of changing points of said vector data, a noise removing means which automatically removes only the noise data in said vector data corrected by said vector data correcting mean, and a film output means which reads the color image data stored in said image memory, based on the vector data with the noise removed by said noise removing means, and clips and outputs it to printing film plates.

## Operation of the Invention

In this invention, when color image data corresponding to the color original, which has been read by the original reading means, is taken into the image memory, the color sense information calculating means reads the stored color image data and calculates the color sense information in the RGB space. Once this calculation is done, the brightness information calculating means calculates the differences in brightness based on this color sense information. Once this calculation is done, the correction calculating means performs a weighted correction calculation on these brightness differences based on the color sense information. Based on the brightness differences, corrected by the weighted correction calcula-

tion, the color image edge detecting means detects the edge information of the color image data stored in the image memory. The detected edge information is displayed on a display device by the edge displaying means. At this time, when the correction positions and correction areas of said edge information displayed on said display device are indicated by the correction indicating device, the mask data means corrects the edge information and makes mask data. The mask data are transferred to the vector converting means and converted to vector data. The converted vector data, corresponding to the edge information, are corrected by the vector data correcting means, and the noise is removed by the noise removing means. Then, the film output means reads the color image data stored in the image memory, based on the vector data with the noise removed, and clips and outputs it to printing film plates.

## Working Examples

Fig. 1 is a block diagram which explains the constitution of an automatic cut-out system which shows a working example of this invention. 1 is a layout table, on which a color original 2 is placed. 3 is a color scanner; it reads the color original 2, and the color image data which has be read is taken into the image memory 4. 5 is a controller part, formed by a computer, etc.; it comprises a color sense information calculating means 5a, a brightness information calculating means 5b, a correction calculating means 5c, a color image edge detecting means 5d, an edge displaying means 5e, a mask data making means 5f, a vector converting means 5g, a vector data correcting means 5h, and a noise removing means 5i. The various means 5a–5i are started based on a control program stored in the program memory 10; the color sense information calculating means 5a reads the color image data corresponding to the color original, which was read from the color scanner 3 which forms the original reading means, from the image memory 4, which forms the image memory, and calculates the color sense information (brightness, saturation, and hue information). Based on the color sense information obtained by this calculation, the brightness information calculating means 5b calculates the brightness differences. Once this calculation is done, the correction calculating means 5c performs a weighted correction calculation based on the color sense information. Based on the brightness differences corrected by this weighted correction, the color image edge detecting means 5d detects the edge information of the color image data stored in the image memory 4. The detected edge information is displayed on a display device 6 by an edge displaying means 5e. At this time, when the correction positions and correction areas of the edge information which are displayed on the display device 6 by the input part 7, which forms the correction indicating means, are indicated by the operator, in a dialog form, the mask data making means 5f corrects the edge information and makes mask data. This mask data, which is raster data, is transferred to the vector converting means 5g and converted to vector data. The vector data, which has been converted according to the edge information, is thinned out and corrected

by the vector data correcting means 5h, and the noise removing means 5i removes the noise. Moreover, the film output means, for example, a layout scanner 8, reads the color image data stored in the image memory 4, based on the vector data with the noise removed, and cuts out and outputs the printing film plates (Y, M, C, and MK plates).

Furthermore, the input part 7 comprises a keyboard 7a and a pointing device 7b; the correction areas of the edge information, displayed on the display device 6, is indicated by points or areas.

Next, the calculation processing operations of the color sense information calculating means 5a, brightness information calculating means 5b, and correction calculating means 5c will be explained with reference to Fig. 2.

Fig. 2 is a schematic diagram which explains the corrected RGB space; R is the red axis, G is the green axis, and B is the blue axis. When vectors are defined below, the symbols will be underlined.

In this diagram, $\underline{W}$ is a vector showing the white point; it corresponds to the point (1,1,1), based on the origin O (the black point). The unsaturated area is defined on the line defined by this vector $\underline{W}$. $\underline{C}$ shows a vector which shows an arbitrary color in the RGB plane (the hashed part of the drawing).

The three-attribute information of the color sense includes brightness, saturation, and hue; they are defined by equations (1)–(5) below.

That is, the brightness b is given by

$$b = N_b \frac{(\underline{C} \cdot \underline{W})}{|\underline{W}|} \qquad \cdots\cdots (1)$$

where $N_b$ is a proportionality constant and (_ · _) indicates an inner product. The saturation s is given by

$$s = N_s \frac{(|\underline{C}|^2 \cdot |\underline{W}|^2 - (\underline{C} \cdot \underline{W})^2)^{1/2}}{|\underline{W}|} \qquad \cdots\cdots (2)$$

where $N_s$ is a proportionality constant.

With respect to the hue, on the other hand, considering the plane in which R+G+B = 1, when the vector from the intersection of the plane and the vector $\underline{W}$ towards the intersection of the plane and the R axis is made the base vector, the vector from the intersection of the plane and the vector $\underline{W}$ to the intersection of the plane and the vector C or an extension of vector C is defined as the hue vector $H_{\bullet}$.[1]

The hue vector $H_{\bullet}$ is given by

[1] *The subscript cannot be read in the original. – Translator's note*

$$H_{*} = \frac{\underline{C} - \frac{(\underline{C}, \underline{W})}{|\underline{W}|^{2}} \underline{W}}{|\underline{C}| \sin\theta} \quad \cdots\cdots (3)$$

where $\theta$ is the angle formed by the vectors $\underline{C}$ and $\underline{W}$.

Therefore, when the angle formed by the hue vector $H_*$ and the base vector is rotated clockwise, as seen from the direction of the vector $\underline{W}$, the hue h is obtained.

Consequently, when the vector $\underline{C}$ is expressed as (r, g, b), the hue h is defined by equations (4) and (5):

$$h = N_h \times \cos^{-1}\left( \frac{(\underline{C}, \underline{H_0})}{|\underline{C}| \cdot |\underline{H_0}|} \right) \quad \cdots\cdots (4)$$

(when g≥b)

$$h = N_h \times \left( 2\pi - \cos^{-1}\left( \frac{(\underline{C}, \underline{H_0})}{|\underline{C}| \cdot |\underline{H_0}|} \right) \right) \quad \cdots\cdots (5)$$

(when g<b)

Therefore, the color sense information calculating means 5a and the brightness information calculating means 5b calculate the color sense information and brightness information, based on the equations (1)–(5).

Moreover, the correction calculating means 5c corrects the brightness differences by using a degeneracy related to the brightness and saturation.

Furthermore, this "degeneracy" can be defined as follows. When there are a number of attributes which describe the characteristics or properties of a certain situation, if we focus on one of these attributes, the states of several other attributes sometimes correspond to the state of this attribute. In such cases, we say that there is a degeneracy with respect to the attribute focused on.

First, let us consider degeneracy related to brightness.

If we consider brightness in a gray-scale image, and consider that in reality only the brightness axis component of one point in the color space of saturation and hue is expressed, the aforementioned degeneracy is considered by how much of the saturation and hue ranges correspond to a certain brightness.

The degeneracy with respect to the brightness $l$ shown in Fig. 2 will be explained.

If the unit vector towards the vector $\underline{W}$, with respect to the brightness $l$, is taken to be $\underline{Ew}$, the area of the part included in the region which can be realized by a plane which has $\underline{Ew}$ through the point defined by $l \cdot \underline{Ew}$ in the normal vector (the equal-brightness plane) is defined as the degree of degeneracy.

Next, the degeneracy with respect to saturation will be explained.

In the degeneracy related to saturation, the saturation is defined as one of the two attributes (saturation and hue) which describe the properties of one point on the equal-brightness plane. The degree of degeneracy related to the saturation s is the circumference of the circle with s on the equal brightness plane as its radius.

Next, the process of calculating corrections by the correction calculating means 5c will be explained.

The correction by the correction calculating means 5c is the calculation process in which the differences due to the other two attributes, saturation and hue, are effectively added to the differences due to brightness.

If the degree of degeneracy related to brightness is Mb and the weight due to the degeneracy related to brightness is Wb, then the weight Wb is defined by equation 6 below. If the degree of degeneracy related to the saturation is Ms, and the weight de to the degeneracy related to saturation is Ws, then the weight Ws is defined by equation 7 below.

$$Wb \propto \alpha_b \cdot Mb \quad \cdots\cdots (6)$$

$$Ws \propto \alpha_s \cdot Ms \quad \cdots\cdots (7)$$

If the difference in the brightnesses of areas *i* and *j* is $\delta^b_{ij}$, the difference equation for the difference $\Delta_{ij}$ in the brightnesses of areas *i* and *j* is defined by equation (8):

$$\text{Difference } \Delta_{ij} = \delta^b_{ij} + Wb \cdot (\delta^s_{ij} + Ws \cdot \delta^h_{ij}) \ \ldots (8)$$

where $\delta^s_{ij}$ shows the difference in saturations and $\delta^h_{ij}$ shows [the difference in] hues.

The ordinary difference equation is defined by the values of brightness and saturation imparted to two pixels. Therefore, if the weight Wb shown in equations (6) and (7) has the indices *bi* and *bj*, and the weight Ws is defined by the indices *si* and *sj*, these equations can be converted to equations (9) and (10):

$$Wb\ (bi,\ bj) = \alpha_b \cdot Mb(b) \cdots\cdots (9)$$

$$Ws\ (si,\ sj) = \alpha_s \cdot Mb(s) \cdots\cdots (10)$$

When calculation is performed based on equations (11)-(14), under the evaluation that the values of the difference equations weighted by the coefficients $a_b$ and $a_s$ and the difference equations of simple addition, without weights, agree when summed over all areas, then

$$\begin{aligned} &\int\int\int \Delta_{ij} db\,ds\,dh \\ &= \int\int\int [\delta^b_{ij} + Wb\ (bi,\ bj) \\ &\quad \times (\delta^s_{ij} + Ws\ (si,\ sj) \cdot \delta^h_{ij}) \\ &\quad ]\ db\,ds\,dh \quad \cdots\cdots (11) \end{aligned}$$

where

$$B = \int^{*} d\, b \cdots\cdots (12)$$

$$S = \int^{*} d\, s \cdots\cdots (13)$$

On this assumption, equations (9) and (10) can be defined by equations (15) and (16).

Assuming

$$H = \int^{*} d\, h \cdots\cdots (14),$$

equations (9) and (10) can be defined as shown in equations (15) and (16).

Assuming

$$H = \int^{*} d\, h \cdots\cdots (14),$$

equations (9) and (10) can be defined as shown in equations (15) and (16).[2]

Furthermore, * in the equations above means integration over the whole range of values which the attribute being focused on can take; in the case of multiple integrals, it refers to integration over the whole range of each attribute for which integration is performed.

$$\alpha_b = \frac{B}{\int^{*} M_b (b)\, d b} \cdots\cdots (15)$$

$$\alpha_s = \frac{S}{\int^{*} M_s (s)\, d s} \cdots\cdots (16)$$

In practice, the controller part 5 calculates the differences $\Delta_{ij}$ by equation (17), based on equations (18)-(22).

$$\Delta_{ij} = \delta^{b}_{ij} + W_b \cdot (\delta^{s}_{ij} + W_s \cdot \delta^{h}_{ij}) \cdots\cdots (17)$$

$$\delta^{b}_{ij} = | b_i - b_j | \cdots\cdots (18)$$

$$\delta^{s}_{ij} = | s_i - s_j | \cdots\cdots (19)$$

$$\delta^{h}_{ij} = | h_i - h_j | \cdots\cdots (20)$$

$$W_b = \sqrt{b_i \cdot b_j} \cdots\cdots (21)$$

$$W_s = \sqrt{s_i \cdot s_j} \cdots\cdots (22)$$

Therefore, by calculating the differences $\Delta_{ij}$ between pixels for the color image data stored in the image memory 4 and judging whether or not they are larger than a previously set value $\alpha$, the color image edge detecting means 5d can judge whether or not there is an edge between the pixel data $D_i$ and $D_j$ and the color image edges can be detected.

In actual calculations, to judge whether a certain pixel is an edge candidate, the edge strength values in the X and Y directions are obtained by equations (23) and (24) below, using the difference equation (17) above, and the edge strength

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[2] *This paragraph is repeated in the original – Translator's note.*

value ES(X,Y) is calculated by equation (25); the judgment about edge candidates is performed by whether the edge strength value is greater than a certain value $\alpha$.

$$SX = \Delta_{ca} + 2\Delta_{ef} + \Delta_{ie} \qquad \cdots\cdots (23)$$

$$SY = \Delta_{ga} + 2\Delta_{ha} + \Delta_{ic} \qquad \cdots\cdots (24)$$

$$ES(X, Y) = |SX| + |SY| \qquad \cdots\cdots (25)$$

Next, the processing operation of automatically cutting out a color image by this invention will be explained by referring to Figs. 3 (a)–(g).

Figs. 3 (a)–(g) are schematic diagrams which explain the sequence of color image automatic cut-out processes according to this invention.

In Fig. 3 (a), 11 is a color original image; it shows a case in which the background is not homogeneous. The image to be cut out in this color original image 11 is a person.

In Fig. 3 (b), 12 shows the color edge detection data; this is displayed on the display 6 by the edge displaying means 5e. 13 is the unneeded edge data; it corresponds to the edge data detected by the color image edge detecting means 5d.

In Fig. 3 (c), 14 is the mask data; it corresponds to the state in which the area outside the cut-out region is encoded by "1," for example, after correcting the color edge detection data 12 shown in Fig. 3 (b), based on the binary boundary data displayed on the display device 6.

In Fig. 3 (d), 15 is the edge vector data; it corresponds to the data obtained by faithfully vectoring the mask data 14 shown in Fig. 3 (c).

In Fig. 3 (e), 17 is the corrected edge vector data; it corresponds to the state in which the number of changing points of the edge vector data 15, shown in Fig. 3 (d), have been thinned by the method discussed below.

In Fig. 3 (f), 18 is the noise removal vector data; it corresponds to the data from which the noise data 16, shown in Fig. 3 (d), are removed by the noise removing means 5i, based on the information discussed below.

In Fig. 3 (g), 19 is the cut-out color image data; it corresponds to the cut-out color image data read from the image memory 4, based on the noise-removed vector data 18 shown in Fig. 3 (f). A case in which it agrees with the person in the color original image shown in Fig. 3 (a) is shown.

When the color original 2 which was placed on the layout table 1 is color-separated and read by the color scanner 3, the color image data which was read (the RGB signals) are received in the image memory 4.

Here, when the start of an image cut-our is indicated by the input part 7, the color image cut-out program stored in the program memory 10 is started and the color sense information calculating means 5a reads the color image data from the

image memory 4, and the color sense information in the RGB space, i.e., the brightness, saturation, and hue, are calculated. The brightness information calculating means 5b calculates the brightness differences from the color sense information obtained by this calculation, and the correction calculating means 5c calculates the aforementioned differences $\Delta_{ij}$ for each pixel by considering the degeneracy related to the saturation and the degree of degeneracy related to the hue. By comparing the difference $\Delta_{ij}$ obtained by this calculation with the previously set value, the color image edge detecting means 5d outputs the color edge detection data 12 and the edge data 13, shown in Fig. 3 (b), to the subsequent edge displaying means 5e. Therefore, the color edge detection data 12 and the edge data 13 are displayed on the display device 6.

Here, when the edge data 13 shown in Fig. 3 (b), for example, is indicated by the input part 7, only the data which the edge displaying means 5e of the controller part 5 has indicated is removed. Next, the mask data making means 5f blocks the data coded as "1," for example, outside the color edge detection data 12, which is considered the border, and makes the mask data 14 shown in Fig. 3 (c). Next, the vector converting means 5g faithfully vectorizes the mask data 14 shown in Fig. 3 (c), and the edge vector data 15 shown in Fig. 3 (d) is produced. At this time, there are cases in which noise data 16 are produced accompanying this conversion.

Therefore, the last stage, the vector data correcting means 5h performs a thinning-out correction processing and a noise removal processing of the edge vector data 15.

Fig. 4 is a schematic diagram which explains the vector data correction processing of this invention; 21 is the original vector data, which corresponds to the vector data produced by the vector converting means 5g. 22 is the corrected vector data; it corresponds to the data in which the number of vector points is reduced by a specified pitch, so that no steps are produced in the original vector data 21.

As can be seen from this drawing, the original vector data 21 is automatically corrected to the corrected vector data 22 by searching for the points which are the pivots of changes on the thin binary lines (critical points) by a direction code. In this way, the roughness of the boundary edges is reduced.

Next, when the noise removing means 5i searches the vector data, according to the following information (1)-(3) and the noise removal rules (1)-(4), the noise data 15 shown in Fig. 3 (d) is automatically removed.

Information:

(1) Lengths of loops

(2) Inclusion relations of loops

(3) Complexity of loops (number of critical points/vector loop lengths)

Rules:

(1) Vector loops with lengths lower than a certain value and complexities greater than a certain value are removed.

(2) Vector loops with lengths greater than a certain value, outermost inclusion relations, and complexities below a certain value are retained.

(3) Vector loops with inner inclusion relations and complexities above a certain value are removed.

(4) Vector loops with inner inclusion relations, lengths above a certain value, and complexities below a certain value are retained as cut-out lines.

In this way, the noise-removed vector data 18 shown in Fig. 3 (f) is produced. Therefore, the layout scanner 8 accesses the image memory 4, while referring to the noise-removed vector data 18 produced by the noise removing means 5i, and extracts only the color image data corresponding to the area within the noise-removed vector data 18. The printing film plates 9, set on output drums not shown in the drawing, are separately exposed; in this way, the cut-out color image data 19, shown in Fig. 3 (g), can be automatically cut out.

Furthermore, the input of the color original 2 may be performed from an input drum of a layout scanner 8.

Next, the automatic cut-out processing operation by this invention will be further explained with reference to Fig. 5.

Fig. 5 is a flow chart which explains an example of the automatic cut-out processing steps of this invention. The steps are shown by (1)–(17).

The processing waits for the reading of the color original 2 by the color scanner 3 to stop (1), and the color image data red in from the color scanner 3 is stored in the image memory 4 (2). Next, it waits for the automatic cut-out indications to be inputted by the input part 7 (3); when the automatic cut-out indications are inputted by the input part 7, the color sense information calculating means 5a calculates the brightnesses, saturations, and hues of the color image data red into the image memory 4 (4). The brightness information calculating means 5b calculates the brightness differences according to the color sense information obtained by this calculation (5). Next, the correction calculating means 5c performs the weighted difference correction calculations, considering the degeneracies related to the aforementioned saturations and hues, on the brightness differences (6). Next, the calculated weighted differences and the previously set constant value are compared, and the color image edge data is detected (7). Next, this result is transferred to the edge displaying means 5e and displayed on the display device 6, as shown, for example, in Fig. 3 (b) (8).

Next, the processing waits for the corrections to the color image edge data drawn by the input part 7 to be indicated (9), and corrects the indicated color image edge data (10). Next, the mask data making means 5f makes the mask data based on the color image edge data after corrections, displayed on the display device 6 (11).

Next, the subsequent vector converting means 5g converts the mask data which was made faithfully to vectors (12). Here, the vector data correcting means 5h thins out and corrects the number of vector points of the vectorized edge data by the method described above (13), and the noise removing means 5i removes the noise of the vector data according to the information (14).

Next, vector data 18 with the noise removed, for example, is outputted to the controller of the layout scanner 8. Therefore, the layout scanner 8 accesses the image memory 4 and waits for only the color image data corresponding to the inside areas of the noise-removed vector data 18 to be read out (15). When this data is read out, the printing film plates 9, set on output drums of the layout scanner 8 not shown in the drawing, are exposed separately for each plate (16).

Next, the processing judges whether all of the film plates have been outputted (17); if the answer is YES, the processing is finished, and if it is NO, the processing returns to step (15).

## Effectiveness of the Invention

As explained above, this invention comprises an original reading means which reads a color original, an image memory which stores the color image data read by this original reading means, a color sense information calculating means which reads this color image data from this image memory and calculates the color sense information in the RGB space, a brightness information calculating means which calculates the differences in brightness based on this color sense information, a correction calculating means which performs a weighted correction calculation on these brightness differences based on this color sense information, a color image edge detecting means which detects the edge information of the color image data stored in this image memory, an edge displaying means which displays this edge information on a display device, a correction indicating device which indicates the correction positions and correction areas of this edge information displayed on this display device, a mask data making means which makes mask data while correcting the correction positions and correction areas displayed on this correction indicating device, a vector converting means which converts this mask data to vector data, a vector data correcting means which thins out and corrects the number of changing points of this vector data, a noise removing means which automatically removes only the noise data in this vector data corrected by this vector data correcting mean, and a film output means which reads the color image data stored in this image memory, based on the vector data with the noise removed by this noise removing means, and clips and

outputs it to printing film plates. Therefore, there are the advantages that the objects to be printed from desired color originals which do not have homogeneous color image backgrounds can be accurately cut out; cut-out processing can be automated for color originals which conventionally were relegated to hand processing; and the accuracy and printing efficiency can be greatly improved, compared by cut-out processing by the mask process.

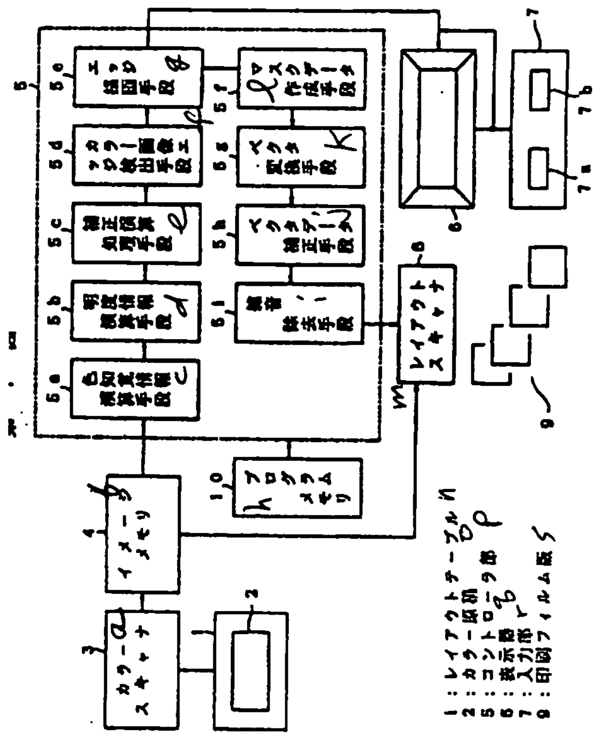
4. Simple Explanation of Drawings:

Fig. 1 is a block diagram which explains the constitution of an automatic cut-out system, which shows a working example of this invention; Fig. 2 is a schematic diagram which explains the normalized RGB space; Fig. 3 (a)–(g) are schematic diagrams which explain the color image automatic cut-out processing steps of this invention; Fig. 4 is a schematic diagram which explains the vector data correction processing of this invention; Fig. 5 is a flow chart which explains an example of the automatic cut-out processing steps of this invention; and Fig. 6 is a block diagram which explains an example of the constitution of a conventional film original plate making device for solid screens.

In the drawings, 1 is a layout table, 2 is a color original, 3 is a color scanner, 4 is an image memory, 5 is a controller part, 5a is a color sense information calculating means, 5b is a brightness information calculating means, 5c is a correction calculating means, 5d is a color image edge detecting means, 5e is an edge displaying means, 5f is a mask data making means, 5g is a vector converting means, 5i is a noise removing means, 6 is a display device, 7 is an input part, 8 is a layout scanner, 9 are printing film plates, and 10 is a program memory.

Agent: Shoko Kobayashi, Patent Attorney

Fig. 1



a. Color scanner

b. Image memory

c. Color sense information calculating means

d. Brightness information calculating means

e. Correction calculating means

f. Color image edge detecting means

g. Edge displaying means

h. Program memory

i. Noise removing means

j. Vector data correcting means

k. Vector converting means

l. Mask data making means

m. Layout scanner

n. Layout table

o. Color original

p. Controller part

q. Display device

r. Input part

s. Printing film plate

Fig. 2

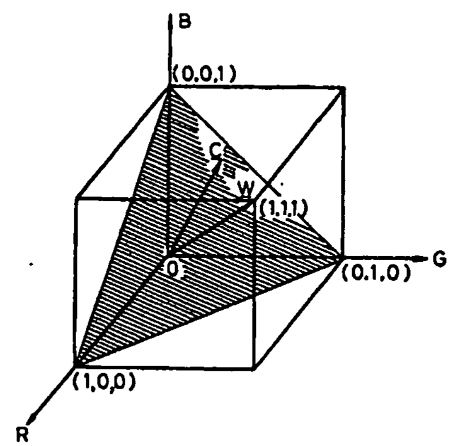



Fig. 3

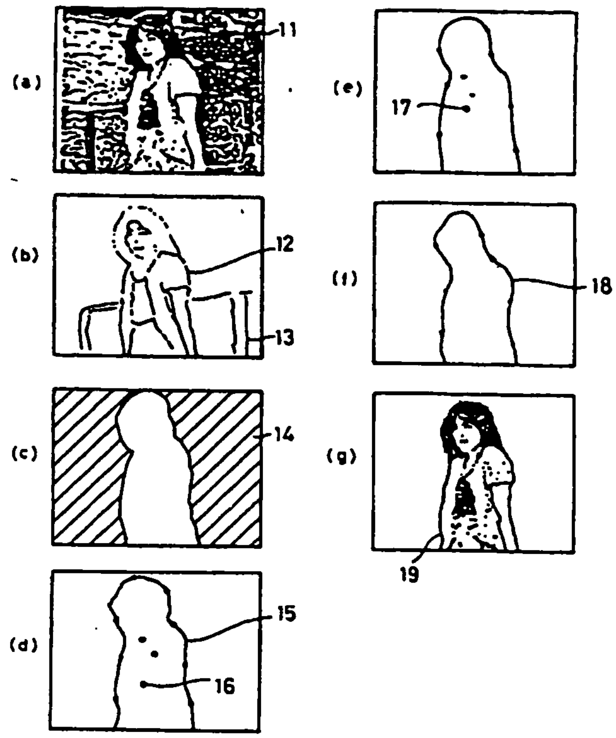



Fig. 4

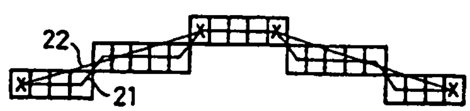
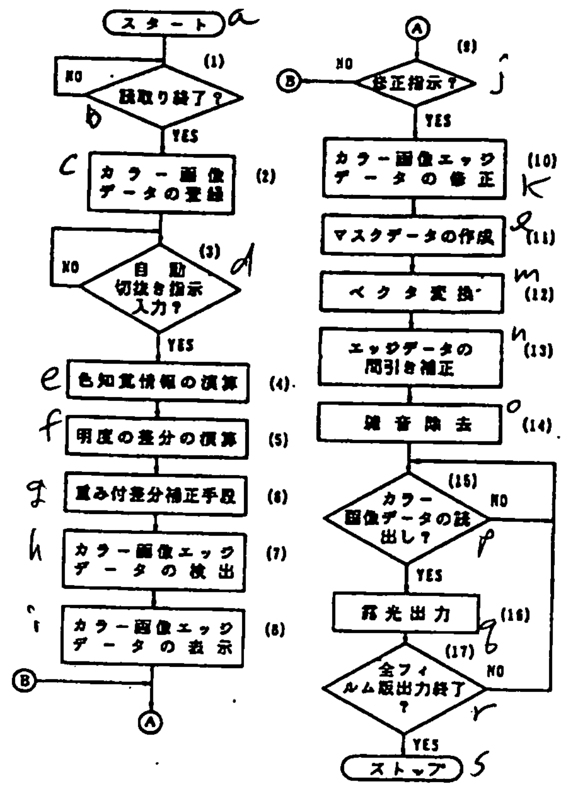



Fig. 5




a. Start

b. Reading finished?

c. Color image data storage

d. Automatic cut-out indications inputted?

e. Color sense information calculation

f. Brightness differences calculation

g. Weighted difference correcting means

h. Color image edge data detection

i. Color image edge data display

j. Corrections indicated?

k. Color image edge data correction

l. Making of mask data

m. Vector conversion

n. Edge data thinning and correction

o. Noise removal

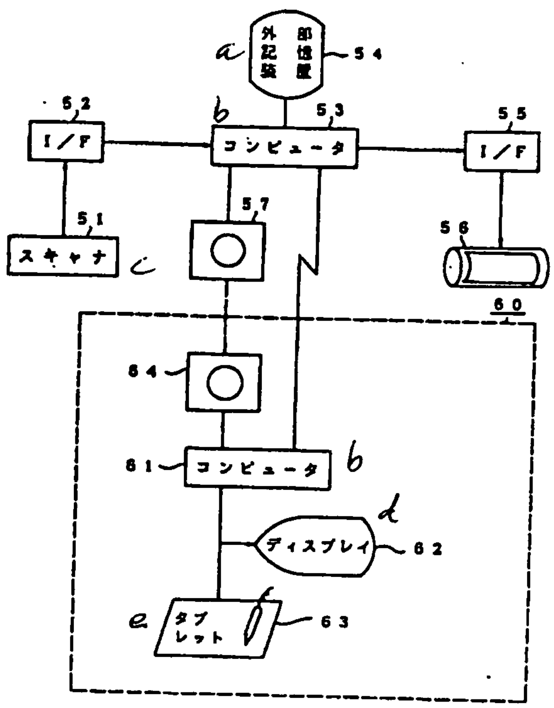
p. Color image data read out?

q. Exposure output

r. All film plate outputs finished?

s. Stop

Fig. 6




a. External storage device

b. Computer

c. Scanner

d. Display

e. Tablet

XP-002299387

*Multi-Resolution Process for Merging Dynamic Screen Sequences*

(beginning not included)
...describe a frame matrix and a pre-selected structural element (Ja189). Proceeding from the two basic operations of dilatation and erosion, complex operators that are adjusted to the objective are developed, by which the merging objective is implemented.

Lee [Lee88] described the use of morphological operators for merging two polarimetric millimeter radar images. The goal is to improve the identification of the courses of streets and area boundaries through the integration of both polarization types. For this purpose Lee defines a set of reliable "core characteristics", which are found in both input images, and a set of potential characteristics, which only comprises the characteristics present in one image. The actual merging takes place through the application of conditional erosion and dilatation operators of both characteristics types. By using the erosion operator a reduction in the radar clutter can be achieved, the conditional dilatation serves the closing of interrupted courses of lines. The result is the improved display of the courses of streets and regional boundaries.

Image algebra [Rit88] is a "high-level language" expansion of the morphological operators, implemented with the goal of making a uniform description of almost all image-processing operations possible. The basic types of this kind of algebra define a value set, in the simplest cases the set of all gray values of the viewed image, or a coordinate set, which enables the integration of different image resolutions and grids. Advanced types define images and screens, such as the Sobel or Prewitt filters. For each of these basic types operations are defined, ranging from the simplest set operations corresponding to the morphological operators all the way to complex operations on images and screens. Ritter et.al. (Rit88) demonstrate a universal path to the integration of multi-sensorial image data also while considering different image resolutions; however, a concrete application for the evaluation of this method is still lacking.

3.5.3 Neuronal Networks

Following the merging of different "imaging" sense organs in biological systems illustrated in chapter 3.4, artificial neuronal networks are also increasingly used for sensor merging. With respect to explanations for the types and topologies of neuronal networks mentioned below we would like to refer to the books by Haykin [Hay94] or Zell [Zel94].

One example that strongly relates to the merging process implemented in the tectum opticum of the rattlesnake stems from Ajjimarangsee and Huntsberger [Ajj88, Hun92]. For the merging and subsequent segmentation of multi-spectral remote sensing data, a multi-stage method comprising three series-connected neuronal networks is suggested. In the first step, two self-organizing characteristics cards are used, one each for the image matrix of the short- and long-wave spectral regions, which serve the clustering the gray input values. The actual data merging takes place in the second step, which consists of single layered perceptron networks and is fed by the first layer. In this step, the six bimodal neurons known from the tectum opticum of the rattlesnake are copied. final third step is formed by another self-organizing card, with which the final clustering and therefore segmentation of the now merged image data is implemented.

As described by Fechner, Godlewski, and Rockleger [Fen95, God95] in the basic approach to the merging of LLTV and FLIR images or screen sequences [Roc95], image merging is

interpreted as a segmentation task. Proceeding from the LLTV image used as the base image, in the FLIR image matrix relevant image regions are identified, which are then inserted into the base image in a targeted fashion. With the use of a neuronal network of the multi-layer-perceptron (MLP) type, the pixels of the FLIR image matrix are classified as "relevant", i.e. to be inserted in the base image, or "not relevant" following a suitable characteristics extraction. The determination which image regions are considered relevant is carried out on the basis of a representative image scene, which is evaluated by an expert and made available to the neuronal network during the training phase together with the characteristics matrices. The problem with this method is that, despite the generalization characteristics of neuronal networks, the identification of the relevant image regions and therefore also correct segmentation cannot be guaranteed in all situations. Further complications arise when inserting the image regions that are classified "relevant" into the base image. If an image object of the FLIR image has a similar gray value as the background stemming from the LLTV image matrix, this results in object deletion. If the gray value characteristics of both input images are very different, the merged image gives in an unnatural impression. This can be corrected by introducing a transition zone, in which a linear transition between the gray values of the base image and those of the FLIR object takes place.

Waxman et. al. [Wax 95, Wax 96] also used a combination of neuronal networks and false-color display for the merging of LLTV and FLIR image data. In the first step, each of the two input images is fed to a center-surround network, which network duplicates the process of lateral inhibition, as it exists in the retina of mammals [Hub 89]. This network essentially carries out a high-pass filtration and local gray value adaptation of the input signals. A following third center-surround network combines the two modified input signals, wherein the LLTV image is fed to the center region and the FLIR matrix to the surround region of the filter. The three signals created this way, i.e. the modified LLTV signal, the modified FLIR signal and the combined image signal, are then assigned to the three color channels of a RGB false color display.

### 3.5.4 Image Merging as an Optimization Problem

In this approach to image merging, the merging process is formulated as a Bayes optimization task. Proceeding from the multi-sensorial input data and an a priori model of the merger results, the merged image with the maximum a posteriori probability (MAP) is sought. Since the optimization task cannot be resolved being this general, several simplifications are implemented. All image data is modeled as Markov Random Fields (MRFs) in order to be able to define an energy function, with which the fusion goal can be described. As a result of the modeling as MRF, only pixels within a pre-defined neighborhood influence the energy functions of the current pixel. Due to the equivalence of Gibbs Random Fields and MRFs, this energy function can be illustrated as a sum, i.e. clique potentials. Cliques are parts of the neighborhood, consisting only of mutually adjoining pixels. The concrete merger task is then formulated by suitably selecting the neighborhood, the clique potentials and the a priori model of the merger result and consists of an optimization of the global energy function of all pixels. Since this energy function is generally not convex, usually stochastic optimization methods such as simulated annealing (SA) or modifications thereof such as iterated conditional modes (ICM) and highest confidence first (HCF) are employed.

In order to achieve improved signal modeling, the individual image matrices are usually described with several coupled grids, the contributions of which are incorporated in the computation of the energy function. A grid is introduced in order to describe the smoothness of the local gray value line, another grid is defined as edge grids between the pixels in order to ... (remainder cut off)

# TRANSLATOR CERTIFICATION

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Morningside | Translations

I, Kerstin Roland, a translator fluent in the German language, on behalf of Morningside Evaluations and Consulting, do solemnly and sincerely declare that the following is, to the best of my knowledge and belief, a true and correct translation of the document(s) listed below in a form that best reflects the intention and meaning of the original text.

**MORNINGSIDE EVALUATIONS AND CONSULTING**

Kerstin Roland

Signature of Translator

Description of Documents Translated:
Multi-Resolution Method for Merging Dynamic Screen Sequences

Date: April 16, 2006